

REMARKS/DISCUSSION OF ISSUES

By this Amendment, Applicant amends claim 2 to correct a typographical error made in a previous Amendment. Accordingly, claims 1-17 are pending in the application.

Reexamination and reconsideration of this application are respectfully requested in view of the following Remarks.

35 U.S.C. § 112, First Paragraph

The Office Action rejects claims 1 and 4-13 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. In particular, the Office Action states that the specification “does not describe the fluorescent material is a photoluminescent material.”

Applicant respectfully disagrees and traverses the rejection of claims 1 and 4-13 under 35 U.S.C. § 112, first paragraph.

The specification discloses:

“a thin layer 7 of fluorescent material, e.g. fluorescent polymer, a dye or an inorganic compound like a phosphor, and a layer 9 that forms a back electrode. A source for generating electromagnetic radiation, here for example a UV source 11, is used to induce excitations, so-called excitons, in the layer 7 of fluorescent material”

Now, it is well-known that a material which emits light in response to UV, visible, or infrared light is defined as a “photoluminescent material.” Attached to this Amendment for the Examiner’s attention are definitions of photoluminescent from Wikipedia, Dictionary.com, and the Kansas State University (KSU) Physics Education Group.

Therefor, Applicant respectfully submits that the specification absolutely provides a written description of the subject matter of claim 1.

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Accordingly, Applicant respectfully submits that claims 1 and 4-13 all meet the requirements of under 35 U.S.C. § 112, first paragraph, and therefore respectfully request that the rejections of claims 1 and 4013 under 35 U.S.C. § 112, first paragraph be withdrawn.

35 U.S.C. § 112, Second Paragraph

The Office Action rejects claims 2-3 and 14-17 under 35 U.S.C. § 112, second paragraph as indefinite because of a typographical error that occurred in the Amendment dated 9 July 2003.

By this Amendment, Applicant corrects that error and therefore respectfully requests that the rejection of claims 2-3 and 14-17 under 35 U.S.C. § 112, second paragraph be withdrawn.

The Office Action also rejects claims 6-7 under 35 U.S.C. § 112, second paragraph as indefinite, alleging that it is not clear what claim 6 is depending on.

Applicant respectfully traverses these rejections.

In the Amendment dated 9 July 2003, Applicant amended claim 6 to depend from claim 5 instead of claim 4 by striking through the "4" (i.e., 4) and adding a "5" with an underline (5). However, the strikethrough mark in the "4" may have been difficult to see and therefore not recognized by the Examiner. Nonetheless, claim 6 depends from claim 5 (which in turn depends from claim 1). Therefore, Applicant respectfully submits that it is clear what claim(s) claim 6 depends from.

Accordingly, Applicant respectfully requests that the rejections of claims 6-7 under 35 U.S.C. § 112, second paragraph be withdrawn.

35 U.S.C. §§ 102 and 103

The Office Action rejects: claims 1-7, 10-12, and 14 under 35 U.S.C. § 102 over Martel U.S. Patent 3,344,280 ("Martel"); claims 8, 9, 13, 15 and 16 under 35 U.S.C. § 103 over Martel; and claim 17 under 35 U.S.C. § 103 over Martel in view of Zhang et al. U.S. Patent 5,798,170 ("Zhang").

Applicant traverses those rejections for at least the following reasons.

Claim 1

Among other things, the display device of claim 1 includes a photoluminescent material for emitting light when excited by an excitation means, and each one of the pixel elements is provided with modulating means a modulating means for modulating an emission of light by the photoluminescent material.

Applicant respectfully submits that Martel fails to disclose or suggest a device having this combination of features.

The Office Action cites reference numerals 14 **AND** 16 as supposedly corresponding to the recited photoluminescent material. Meanwhile, Martel teaches that reference numerals 14 and 16 correspond to **two completely separate, different materials**. Element 14 is an electroluminescent material, while element 16 is a phosphorescent material.

Therefore, **only** the phosphorescent material 16 is a photoluminescent material, as recited in claim 1.

Meanwhile, Martel does **not** disclose that each one of the pixel elements is provided with modulating means for modulating an emission of light by the phosphorescent material 16. In that regard, in particular Applicant respectfully submits that Martel does **not** teach that the elements 12, 18 and 22, cited in the Office Action, modulate an emission of light by the phosphorescent material 16.

Indeed, elements 12, 18 and 22 do not perform any light modulation at all – of either light emitted by phosphorescent material 16 OR light emitted by electroluminescent material 14. That is, Martel teaches that phosphorescent material 16 and electroluminescent material 14 are connected in series across the AC current source 22. The impedance of phosphorescent material 16 is modulated by light from ultraviolet/infra-red (UV/IR) activating source 24/24a in combination with mask 20/20a, and the resulting modulated impedance in

phosphorescent material 16 impresses a modulated voltage across electroluminescent material 14 (see, e.g., col. 2, lines 61-71; col. 4, lines 9-17). Thus, the light-modulating means of Martel is actually the UV/IR activating source 24/24a in combination with mask 20/20a.

Accordingly, for at least these reasons, Applicant respectfully submits that the device of claim 1 is patentable over Martel.

Claim 2

Among other things, the display device of claim 2 includes a luminescent material for emitting light when excited by means for generating electromagnetic radiation, and that each one of the pixel elements is provided with modulating means for modulating an emission of light by the luminescent material.

The Office Action has cited reference numerals 14 **AND** 16 as supposedly corresponding to the recited luminescent material. Meanwhile, as explained above, Martel teaches that reference numerals 14 and 16 correspond to **two completely separate, different materials**. Element 14 is an electroluminescent material, while element 16 is a phosphorescent material.

Accordingly, Martel does **not** teach that electroluminescent material 14 emits light when excited by **electromagnetic radiation**, but rather emits light in response an alternating voltage impressed across it by the change in resistance of phosphorescent material 16 (see, e.g., col. 4, lines 43-45). So element 14 cannot correspond to the luminescent material recited in claim 2.

That is, Martel discloses a device having two different types of luminescent materials - phosphorescent (photoluminescent) material 16 and electroluminescent material 14 - where the first (phosphorescent) material 16 emits light in response to electromagnetic radiation, while light produced by the second (electroluminescent) material 14 is modulated by the voltage impressed across it by the changing impedance of phosphorescent material

16. In contrast, in the device of claim 2, a single luminescent material emits light in response to electromagnetic radiation, while the light produced by that material is modulated by a separate modulating means (e.g., electrodes disposed on either side thereof).

Meanwhile, although the phosphorescent material 16 does emit light when excited by electromagnetic radiation from UV/IR activating source 24/24a, Martel does not disclose that each one of the pixel elements is provided with modulating means for modulating an emission of light by the phosphorescent material 16. In that regard, in particular Applicant respectfully submits that Martel does not teach that the elements 12, 18 and 22, cited in the Office Action, modulate any emission of light by the phosphorescent material 16 – which is the only material that can possibly correspond to the recited luminescent material for emitting light when excited by means for generating electromagnetic radiation.

Indeed, as explained above with respect to claim 1, the light-modulating means disclosed by Martel is actually the UV/IR activating source 24/24a in combination with mask 20/20a (see, e.g., col. 2, lines 61-71; col. 4, lines 9-17).

So, Applicant respectfully submits, the device of claim 2 is quite different from the device disclosed by Martel, and Martel does not disclose the device of claim 2.

Accordingly, for at least these reasons, Applicant respectfully submits that the device of claim 2 is patentable over Martel.

Claims 3 and 14-16

Claims 3 and 14-16 depend from claim 2 and are deemed patentable over Martel for at least the reasons set forth above with respect to claim 2.

Claims 4-13

Claims 4-13 depend from claim 1 and are deemed patentable over Martel for at least the reasons set forth above with respect to claim 1, and for

the following additional reasons.

Claim 5

Among other things, in the display device of claim 5, the modulating means comprise means for applying an electric field to the photoluminescent material.

Applicant respectfully submits that Martel does not teach that the light emitted by the phosphorescent (photoluminescent) material 16 is modulated by any means for applying an electric field to the phosphorescent material 16. Instead, Martel teaches that the light emitted by the phosphorescent material 16 is modulated by the UV/IR light source 24/24a in combination with the image forming mask 20, 20a (see, e.g., col. 4, lines 9-17).

The Office Action states that “Martel clearly discloses that the voltage is applied across the photoluminescent material and the electroluminescent material.”

Applicant agrees.

However, Martel does **not** disclose that the voltage is a “modulating means for modulating an emission of light by the photoluminescent material” – or for modulating any emission of light at all! Instead, Martel clearly indicates (see, e.g., col. 4, lines 9-17) that the UV/IR light source 24/24a in combination with the image forming mask 20, 20a modulate the light emitted by the phosphorescent material 16, and in turn the impedance of the phosphorescent material 16 modulates light emitted by electroluminescent material 14.

Accordingly, for at least these reasons, Applicant respectfully submits that the device of claim 5 is patentable over Martel.

Claims 8-9

The Office Action claims that the features of claims 8-9 are obvious design choices.

Applicant respectfully disagrees. In particular, there is no suggestion in the prior art of imposing such a large an electric field as 400 MV/m across a photoluminescent material. Moreover, there is no reason to believe that anyone trying to optimize Martel's device – which operates on completely different operating principles than the devices of claims 8 and 9 – would ever come up with an idea to impose such a large an electric field as 400 MV/m across a photoluminescent material.

Accordingly, for at least these reasons, Applicant respectfully submits that the devices of claims 8-9 are patentable over Martel.

CONCLUSION

In view of the foregoing explanations, Applicant respectfully requests that the Examiner reconsider and reexamine the present application, allow claims 1-17 and pass the application to issue. In the event that there are any outstanding matters remaining in the present application, the Examiner is invited to contact Kenneth D. Springer (Reg. No. 39,843) at (571) 283.0720 to discuss these matters.


If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment (except for the issue fee) to Deposit Account No. 50-0238 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17, particularly extension of time fees.

Respectfully submitted,

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photo-graphic (fō'tə grāf'ik), *adj.* 1. of, pertaining to, used in, or produced by photography. 2. suggestive of a photograph; extremely realistic and detailed: *photographic accuracy*. 3. remembering, reproducing, or functioning with the precision of a photograph: *a photographic memory*. [1839] —**photo-graph'i-cal-ly**, *adv.*

photo-graphy (fō'tə grā'fē), *n.* 1. the process or art of producing images of objects on sensitized surfaces by the chemical action of light or of other forms of radiant energy. 2. CINEMATOGRAPHY. [1839]

photo-gravure (fō'tə grā v'yūr', -grā'vūr), *n.* 1. a process, based on photography, by which an intaglio engraving is formed on a metal plate, from which ink reproductions are made. 2. the plate itself. 3. a print made from it. [1875-80] —**photo-gravure-ist**, *n.*

photo-induced (fō'tō in dū'st', -dyū'st'), *adj.* induced by light. [1945-50]

photo-ion-ization (fō'tō iō nā zā'shən), *n.* the ionization of an atom of gas through loss of a bound electron induced by absorption of a photon. [1910-15]

photo-journal-ism (fō'tō jūr'nəl iz'm), *n.* journalism in which the story is told largely in captioned photographs. [1940-45] —**photo-jour-nal-ist**, *n.*

photo-ki-ne-sis (fō'tō kī nē'sis, -kī-), *n. Biol.* movement occurring upon exposure to light. [1900-05] —**photo-ki-netic** (-net'ik), *adj.*

photo-lith-o-graph (fō'tə lith'ə grāf', -grāf'), *n. v.* —**graphed**, **-graph-ing**. —*n.* 1. Also called **photo-lith-o-print** (-print'), a lithograph printed from a stone or metal plate upon which a picture or design has been formed by photography. —*v.t.* 2. to make a photolithograph of. [1850-55]

photo-litho-graphy (fō'tō li thog'rā fē), *n.* 1. the technique or art of making photolithographs. 2. a process whereby integrated and printed circuits are produced by photographing the circuit pattern on a photosensitive substrate and chemically etching away the background. [1855-60] —**photo-lith-o-graph-ic** (-lith'ə grāf'ik), *adj.* —**photo-litho-graph-er**, *n.*

photo-lu-mi-nescence (fō'tə lū'mē nēs'əns), *n.* luminescence induced by the absorption of infrared radiation, visible light, or ultraviolet radiation. [1885-90] —**photo-lu-mi-nes-cent**, *adj.*

photo-ly-sis (fō'tō lō'sis), *n.* the chemical decomposition of materials under the influence of light. [1910-15] —**photo-lytic** (fō'tō līt'ik), *adj.*

photo-mac-ro-graph (fō'tə mak'rə grāf', -grāf'), *n.* a photograph made through a microscope of low power. [1945-50] —**photo-mac-ro-graphy** (-ma krog'rā fē), *n.*

photo-map (fō'tə map'), *n. v.* —**mapped**, **-map-ping**. —*n.* 1. a mosaic of aerial photographs marked as a map, with grid lines, place names, etc. —*v.t.* 2. to map by means of aerial photography. [1865-70]

photo-me-chan-i-cal (fō'tō mē kən'ī kəl), *adj.* noting or pertaining to any of various processes for printing from plates or surfaces prepared by the aid of photography. [1885-90] —**photo-me-chan-i-cal-ly**, *adv.*

photo-meter (fō'tō mē'tər), *n.* an instrument that measures luminous intensity or brightness, luminous flux, light distribution, color, etc., usually by comparing the light emitted by two sources, one source having certain specified standard characteristics. [1770-80]

photo-metry (fō'tō mē'trē), *n.* the measurement of the intensity of light or of relative illuminating power. [1815-25; < NL *photometria*. See PHOTOMETER] —**photo-met-ric** (-lē mē'tr'ik), **photo-met-ri-cal**, *adj.* —**photo-met-ris-tic**, **photo-met-ri-cian** (-trish'ən), *n.*

photo-mi-cro-graph (fō'tō mī'krə grāf', -grāf'), *n.* a photograph taken through a microscope. [1855-60] —**photo-mi-cro-graphy** (-krog'rā fē), *n.*

photo-mi-cro-scope (fō'tō mī'krə skōp'), *n.* a microscope having an illuminator and a camera mechanism for producing a photomicrograph. [1905-10] —**photo-mi-cro-scope-y** (-kros'kə pē), *n.*

photo-mon-tage (fō'tə mon tāzh'), *n.* a combination of several photographs joined together for artistic effect or to show more of the subject than can be shown in a single photograph. [1930-35]

photo-mo-saic (fō'tō mō zā'ik), *n.* MOSAIC (def. 4). [1955-60]

photo-multi-pli-er (fō'tō mul'ti plī'ər), *n.* a light detector that amplifies a photon's signal by using a photocathode and a series of electrodes to create a cascade of electrons. [1935-40]

photo-mural (fō'tə myō'rəl), *n.* a wall decoration consisting of a very large photograph or set of photographs. [1930-35] —**photo-mu-ral-ist**, *n.*

pho-ton (fō'ton), *n.* a quantum of electromagnetic radiation, usually considered as an elementary particle that is its own antiparticle and that has zero rest mass and charge and a spin of one. [1926; < Gk *phōtō* (see PHOT) + -on'] —**pho-ton-ic**, *adj.*

photo-off-set (fō'tō ōf'set', -ōf'), *n. v.* —**set**, **-setting**. —*n.* 1. a method of printing, based on photolithography, in which the inked image is transferred from the metal plate to a rubber surface and then to the paper. —*v.t.* 2. to print by photo-offset. [1925-30]

photo-oppor-tu-nity, *n.* a brief period set aside, esp. for the media, to take photographs of public figures or noteworthy events. Also, **photo-op** (op). [1970-75]

photo-top-a-thy (fō'top'ə thē), *n.* movement of an organism in response to the intensity of light, esp. away from the source of light. [1895-1900] —**photo-top-ic** (fō'tə path'ik), *adj.*

photo-to-ri-od (fō'tō pē'rē ōd), *n.* the interval in a 24-hour period during which an organism is exposed to light. [1915-20] —**photo-to-ri-od-ic** (-ōd'ik), *adj.* —**photo-to-ri-od-i-cal-ly**, *adv.*

photo-to-ri-od-ism (fō'tō pē'rē ō diz'm), also **photo-to-ri-od-ic-ity** (-pē'rē ō diz'itē), *n.* the effect of photoperiods on an organism's growth, fitness, and behavior. [1915-20]

photo-philic (fō'tə fīl'ik), also **photo-phili-ous** (fō'tə fē'lē ōs), *adj.* of or pertaining to an organism, as a plant, that is receptive to, seeks, or thrives in light. [1895-1900]

photo-pho-bi-a (fō'tə fō'bē ə), *n.* 1. an abnormal sensitivity to or intolerance of light, as in iritis. 2. an abnormal fear of light. [1790-1800] —**photo-pho-bic**, *adj.*

photo-phore (fō'tə fō'r', -fō'r'), *n.* a luminous organ of certain fishes and crustaceans. [1880-85]

photo-phos-pho-ryl-a-tion (fō'tə fōs'fēr ə lā'shən), *n.* phosphoryla-

tion that uses light as a source of energy, as during photosynthesis. [1955-60]

photo-pla (fō'tō plā), *n.* vision in bright light (opposed to *scotopia*). [1910-15] —**photo-top-ic** (-top'ik, -tō'p'ik), *adj.*

photo-play (fō'tə plā'), *n.* 1. a motion picture. 2. the scenario for it; screenplay. [1910-15, Amer.] —**photo-play-er**, *n.*

photo-print (fō'tə prīnt'), *n.* 1. a photographic print. 2. a print made by a photomechanical process; photocopy. [1885-90] —**photo-print-er**, *n.* —**photo-print-ing**, *n.*

photo-re-al-ism (fō'tō rē'ə liz'm), *n.* (sometimes cap.) a style of painting depicting scenes in meticulously realistic detail, in emulation of photography. [1960-65] —**photo-re-al-ist**, *n.* —**photo-re-al-ism**, *n.*

photo-re-cap-tion (fō'tō rē'p'ishən), *n.* the physiological perception of light. [1905-10] —**photo-re-cap-tive**, *adj.*

photo-re-cap-tor (fō'tō rē'p'ishər), *n.* a membrane protein or end organ that is stimulated by light. [1905-10]

photo-re-con-nais-sance (fō'tō rē'kō'nā'səns, -zəns), *n.* reconnaissance using aerial photography. [1940-45]

photo-scan (fō'tə skān'), *v.t.* —**scanned**, **-scan-ning**, to study the distribution of a radioactive isotope or radiopaque dye in (a body organ or part) through the use of x-rays. [1955-60]

photo-sen-si-tive (fō'tə sēn'si'tiv), *adj.* sensitive to light or similar radiation.

photo-sen-si-tiv-i-ty (fō'tə sēn'si'tiv'itē), *n.* 1. the quality of being photosensitive. 2. abnormal sensitivity of the skin to ultraviolet light, usually following exposure to certain drugs or other sensitizing chemicals. [1915-20]

photo-sen-si-tize (fō'tə sēn'si'tīz'), *v.t.* —**tized**, **-tiz-ing**, to make (a material) photosensitive, as by application of a photosensitive emulsion. [1920-25] —**photo-sen'si-tiz-a-tion**, *n.* —**photo-sen'si-tiz-er**, *n.*

photo-sphere (fō'tə sfēr'), *n.* a sphere of light or radiance. [1655-65] —**photo-spher-ic** (-sfer'ik), *adj.*

Photo-stat (fō'tə stat'), *n. v.* —**stat-ed** or **-stat-ted**, **-stat-ing** or **-stat-ting**. 1. Trademark, a camera for making facsimile copies of documents, drawings, etc., in the form of paper negatives. —*n.* 2. (often i.c.) a copy made with this camera. —*v.t.* 3. (i.c.) to copy with this camera. —**photo-stat-er**, **photo-stat-ter**, *n.* —**photo-stat-ic**, *adj.*

photo-syn-the-sis (fō'tə sīn'thē'sis), *n.* the production of complex organic materials, esp. carbohydrates, from carbon dioxide, water, and inorganic salts, using sunlight as the source of energy and with the aid of chlorophyll and associated pigments. [1895-1900] —**photo-syn-thet-ic** (-thet'ik), *adj.* —**photo-syn-thet-i-cal-ly**, *adv.*

photo-tax-is (fō'tə tak'sis), also **photo-tax-y**, *n.* movement of an organism toward or away from a source of light. [1900-05] —**photo-tac-tic** (-tak'tik), *adj.* —**photo-tac-tic-ally**, *adv.*

photo-to-leg-ra-phy (fō'tō tō leg'rā fē), *n.* an early technology for the transmission of facsimiles. [1885-90]

photo-ther-a-py (fō'tə thēr'ə pē), *n.* the treatment of disease by means of exposure to light. [1895-1900] —**photo-to-ther-a-pist** (fō'tō thēr'ə p'ist), *adj.* —**photo-to-ther-a-pist**, *n.*

photo-tox-in (fō'tə tōk'sin), *n.* a plant toxin that causes an allergic reaction in a susceptible person who touches or ingests it and is subsequently exposed to sunlight.

photo-troph (fō'tə trōf', -trōf'), *n.* any organism that uses light as its principal source of energy. [1940-45] —**photo-troph-ic**, *adj.*

photo-trop-ic (fō'tə trōp'ik, -trō'p'ik), *adj.* growing toward or away from the light. [1895-1900] —**photo-trop-i-cal-ly**, *adv.*

photo-tro-pism (fō'tō trō'piz'm, fō'tō trō'piz'm), *n.* phototropic tendency or growth. [1895-1900]

photo-tube (fō'tə tūb', -tūb'), *n.* an electron tube with a photosensitive cathode, used like a phototell. [1925-30]

photo-type (fō'tə tīp'), *n.* 1. a printing plate with a relief printing surface produced by photography. 2. any process for making such a plate. 3. a print made from it. [1855-60] —**photo-type-ic** (-tīp'ik), *adj.*

photo-ty-pog-ra-phy (fō'tō tī'pog'rā fē), *n.* 1. the art or technique of making printing surfaces by light or photography, by any of a number of processes. 2. PHOTOCOMPOSITION. [1885-90] —**photo-ty-po-graph-ic** (-pē grāf'ik), *adj.*

photo-volt-aic (fō'tō vōl'tā'ik, -vōl'), *adj.* of or pertaining to a material or device in which electricity is generated as a result of exposure to light. [1920-25]

photo-volt-a-ics (fō'tō vōl'tā'iks, -vōl'), *n.* 1. (used with a sing. v.) a field of semiconductor technology involving the direct conversion of electromagnetic radiation, as sunlight, into electricity. 2. (used with a pl. v.) devices designed to perform such conversion. [1975-80]

phr, *phrase*.

phrag-mi-tes (frāg mī'tēz), *n.* any of several tall grasses of the genus *Phragmites*, having plumed heads, growing in marshy areas, esp. the common reed *P. australis* (or *P. communis*). [< NL (1820) < Gk *phragmites* growing in hedges = *phragma* (a) fence, screen (n. der. of *phrassein* to fence in, hedge around) + -ites -trē']

phrag-mo-plast (frāg'mə plāst'), *n.* the cytoplasmic structure that forms at the equator of the spindle after the chromosomes have divided during the anaphase of plant mitosis, and that initiates cell division. [1910-15; < Gk *phragma* (a) fence (see PHRAGMITES) + -o- + -PLAST]

phras-al (frā'zəl), *adj.* of, pertaining to, or consisting of a phrase or phrases. [1870-75] —**phras-al-ly**, *adv.*

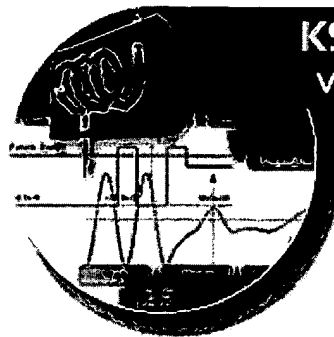
phras-al verb, *n.* a combination of verb and one or more adverbs or prepositions, as *catch on*, *take off*, or *put up with*, functioning as a single semantic unit and often having an idiomatic meaning not predictable from the meanings of the individual parts. [1875-80]

phrase (frāz), *n. v.* —**phrased**, **-phras-ing**. —*n.* 1. a sequence of two or more words arranged in a grammatical unit and lacking a finite verb or such elements of clause structure as subject and verb, as a preposition and a noun or pronoun, an adjective and noun, or an adverb and verb, esp. such a construction acting as a unit in a sentence. 2. a characteristic, current, or proverbial expression. 3. a way of speaking, mode of expression, or phraseology. 4. a brief utterance or remark. 5. a division of a musical composition, commonly a passage of four or eight measures, forming part of a period. 6. a sequence of dance motions making up

part of a choreographic pattern. —*v.t.* 1. to express in words. 2. to express in a phrase. —*v.i.* 10. to perform a musical phrase. [1520-30; (n.) back form *phrasis* < L: diction, style. < Gk *phrō* show, tell]

phrase-book, *n.* a small book containing phrases and their equivalents in a foreign language. [1885-95]

phrase-mak-er (frāz'mā'kər), *n.* 1. a person who makes up phrases. 2. a person who makes up phrases. 3. a person who makes up phrases. 4. a person who makes up phrases. 5. a person who makes up phrases. 6. a person who makes up phrases. 7. a person who makes up phrases. 8. a person who makes up phrases. 9. a person who makes up phrases. 10. a person who makes up phrases. 11. a person who makes up phrases. 12. a person who makes up phrases. 13. a person who makes up phrases. 14. a person who makes up phrases. 15. a person who makes up phrases. 16. a person who makes up phrases. 17. a person who makes up phrases. 18. a person who makes up phrases. 19. a person who makes up phrases. 20. a person who makes up phrases. 21. a person who makes up phrases. 22. a person who makes up phrases. 23. a person who makes up phrases. 24. a person who makes up phrases. 25. a person who makes up phrases. 26. a person who makes up phrases. 27. a person who makes up phrases. 28. a person who makes up 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Modeling Light Emission to Explain Phosphorescence

Introduction

By definition photoluminescent objects emit visible light when light, visible or UV, is shined upon them. Two broad categories are phosphorescence (glow-in-the-dark) and fluorescence. The tutorial "[Modeling Light Emission by Fluorescent Lamps](#)" explores that type of emission. Here we will consider phosphorescence.

Photoluminescent materials such as the phosphor coating found on fluorescent tubes, fluorescent minerals, and phosphorescent toothbrushes contain many solid atoms. As a result, these materials have valence and conduction energy bands that are separated by an energy gap. As we have seen, photoluminescent solids also contain many impurity atoms which result in the formation of a band of energy levels found inside the energy gap of the solid material.

As a brief review, the animation represents an energy band diagram for the phosphor coating found in a typical "white" fluorescent lamp that emits visible light.



Photoluminescence

From Wikipedia, the free encyclopedia

Photoluminescence is a process in which a chemical compound absorbs a photon with a wavelength in the range of visible electromagnetic radiation, thus transitioning to a higher electronic energy state, and then radiates a photon back out, returning to a lower energy state. The period between absorption and emission is typically extremely short, on the order of 10 nanoseconds. Under special circumstances, however, this period can be extended into minutes or hours.

Ultimately, available chemical energy states and allowed transitions between states (and therefore wavelengths of light preferentially absorbed and emitted) are determined by the rules of quantum mechanics. A basic understanding of the principles involved can be gained by studying the electron configurations and molecular orbitals of simple atoms and molecules. More complicated molecules and advanced subtleties are treated in the field of computational chemistry.

Forms of photoluminescence

The simplest photoluminescent processes are **resonant radiations**, in which a photon of a particular wavelength is absorbed and an equivalent photon is immediately emitted. This process involves no significant internal energy transitions of the chemical substrate between absorption and emission and is extremely fast, on the order of 10 nanoseconds.

More interesting processes occur when the chemical substrate undergoes internal energy transitions before re-emitting the energy from the absorption event. The most familiar such effect is **fluorescence**, which is also typically a fast process, but in which some of the original energy is dissipated so that the emitted light is of lower energy than that absorbed.

An even more specialized form of photoluminescence is **phosphorescence**, in which the energy from absorbed photons undergoes intersystem crossing into a state of higher spin multiplicity (*see term symbol*), usually a triplet state. Once the energy is trapped in the triplet state, transition back to the lower singlet energy states is quantum mechanically forbidden, meaning that it happens much more slowly than other transitions. The result is a slow process of radiative transition back to the singlet state, sometimes lasting minutes or hours. This is the basis for "glow in the dark" substances.

Further reading

Donald A. McQuarrie, John D. Simon. *Physical Chemistry, a molecular approach*. University Science Books, 1997.

External links

- Photoluminescent Safety (<http://www.globritephotoluminescent.com/>)

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adj.

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pho'to-lu'mi-nes'cence *n.*

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n.

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photoluminescent

Having the ability to become luminescent upon exposure to visible light.

Origin: photo-+ L. Lumen, light

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